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2018

## Preparing for the future: 2017–2018 ANNUAL REPORT

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# Preparing for the future

2017–2018 ANNUAL REPORT



NATIONAL STRATEGIC  
RESEARCH INSTITUTE  
*at the University of Nebraska*



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## LETTER FROM THE EXECUTIVE DIRECTOR

# A new world. A new response.

American warfighters have faced the possibility of confronting Weapons of Mass Destruction (WMD) on and off the battlefield for many generations. The complexity, stealth, and destructive potential of these weapons have increased with each passing decade.

Today, the vigilance in understanding, detecting and neutralizing these threats is one of the most important missions the men and women of our Armed Services undertake. They cannot, however, accomplish this alone. They must partner with experts in other federal agencies, in business, and in higher education to develop capabilities that keep our nation ahead of the threats.

That is the origin and foundation of the National Strategic Research Institute (NSRI) as a University Affiliated Research Center (UARC).

### PREPARING FOR THE FUTURE

Now in our sixth year, the NSRI serves at the request of the United States Strategic Command (USSTRATCOM) in affiliation with the University of Nebraska (NU). With the award of a new 5-year contract in April 2018, I'm proud to say that we have an opportunity to continue our research to support the brave men and women of our armed forces.

This contract renewal is a vote of confidence that the NSRI and NU are able to address some of the most complex research and development projects designed to combat WMD.

Our exceptionally talented researchers have delivered on every task and in many cases exceeded expectations. They have been applauded for their groundbreaking research support to the Department of Defense (DoD) and other government agency missions.

Over the next five years, we have an excellent opportunity to continue the growth of our research portfolio. This research has never been more important as we enter an era of a multi-domain world threat. We are combating the threat of WMD on multiple fronts, so we will continue to do whatever we can to "get the scientist into the foxhole" in service of the requirements of the warfighters. We are also investing in critical new hires that meet some of our specific subject matter expertise requirements across Chemical, Biological, Radiological, Nuclear and Explosive (CBRN-E) missions.

The foundation for NSRI's future is solid. We will continue to improve on meeting the research requirements for USSTRATCOM and the many other commands and agencies that hold the missions to deter, defend, and defeat adversaries of our national security.

A handwritten signature in black ink that reads "Robert C. Hinson". The signature is fluid and cursive.

Robert Hinson  
NSRI Executive Director  
Lieutenant General, U.S. Air Force (Ret.)

# Essential to the Mission and to the World.

The National Strategic Research Institute (NSRI) at the University of Nebraska (NU) is a University Affiliated Research Center (UARC) established by the Department of Defense (DoD). UARCs exist within a university or college to provide essential engineering, research and/or development capabilities to the DoD through long-term, strategic relationships. NSRI is one of only 13 UARCs across the nation.

NSRI was established in 2012 as a strategic partner to United States Strategic Command (USSTRATCOM) to provide mission-essential research and development. Our success is driven by the unique perspectives and research methods provided by our partnership with the University of Nebraska. The research community of NSRI includes more than 350 University of Nebraska researchers across numerous disciplines and facilities.

## **Combatting WMD. Focusing on Deterrence.**

The American people and the American economy are increasingly exposed to grave risks that threaten their safety and vitality. The 2017 U.S. National Security Strategy unequivocally states that hostile actors are accelerating activities that exploit vulnerabilities across our nation's physical and cyber domains.

State and non-state actors are escalating their attempts to acquire Chemical, Biological, Radiological, Nuclear and Explosive (CBRN-E) weapons. At the same time, daily cyber attacks are negatively impacting our country's economy and critical infrastructure. The threat of biological incidents — whether the result of an attack, accident, or natural outbreak — also continues to increase. This requires action to address them at their source.

Countering these threats is complex and technically demanding. It requires synergy between the dedicated professionals in academia, industry, the military, and government. NSRI provides a venue for this collaboration. We will build upon our vast research and the inroads its made in combatting weapons of mass destruction and continue to emphasize USSTRATCOM's enduring core mission of the deterrence and assurance operations of U.S. nuclear forces, including Nuclear Command, Control, and Communications (NC3).

NSRI will also address the areas identified by the Defense Science Board Task Force on Deterring, Preventing, and Responding to the Threat or Use of Weapons of Mass Destruction: Early Warning, Chemical and Biological Threats, and Nuclear Threats.



*United States Strategic Command (USSTRATCOM) deters strategic attack and employs forces, as directed, to guarantee the security of our nation and our allies.*

*"First, the Task Force found that timely warning of proliferation significantly expands options for deterrence. Second, chemical and biological threats have historically been addressed through protection or response; the Task Force recommends these threats can and should be addressed more broadly in a deterrence context. Finally, nuclear deterrence requires relearning much of what has been forgotten with regards to the principles, but applying them with new tools and unprecedented integration. That integration should leverage conventional, nuclear, and non-kinetic capabilities coupled with messaging and demonstrated operational flexibility to strengthen deterrence and assurance, better manage escalation risks, and widen the options available to leadership."*

**CRAIG FIELDS**  
*Chairman, Defense Science Board (DSB)*

NSRI partners with federal agencies, non-governmental organizations (NGOs), allied foreign research institutions, national laboratories, and other universities. These partnerships generate innovative research solutions in the prevention, detection, protection, response, and recovery from Weapons of Mass Destruction (WMD).

The NSRI research portfolio includes five research-focus areas that align to support the following critical mission areas within the DoD.

## RESEARCH FOCUS AREAS

### ACTIVE AND PASSIVE DEFENSE AGAINST WEAPONS OF MASS DESTRUCTION

develops medical innovations and countermeasures from discovery and design to manufacturing, bio-containment, and clinical treatment

### NUCLEAR DETECTION AND FORENSICS

provides rapid, accurate, and field-deployable nuclear detection and forensics technology

### DETECTION OF CHEMICAL AND BIOLOGICAL WEAPONS

integrates tools and methods for genomic, proteomic, bioinformatics, and nanotechnology for accurate and rapid detection of new and emerging threats

### CONSEQUENCE MANAGEMENT

designs solutions to protect, respond, and restore infrastructure from a Chemical, Biological, Radiological, Nuclear and Explosive (CBRN-E) incident

### MISSION-RELATED RESEARCH

provides scholarly solutions for evolving questions in the operating procedures and analysis of Space, Cyber & Telecommunications Law and Policies

## Beginning the Next Chapter of NSRI.

Since the National Strategic Research Institute (NSRI) was established in 2012, the Department of Defense (DoD) and its agencies have validated our dedication and commitment to their missions with dozens of project awards. On April 5, 2018, United States Strategic Command (USSTRATCOM) validated our successful performance and commitment by awarding the renewal of the NSRI as a University Affiliated Research Center (UARC) with another five-year contract valued at \$92 million — a nearly 10% increase from the original contract.

Under this new five-year UARC contract, NSRI research will continue to focus on the critical challenges that align with the mission areas of the DoD and other governmental agencies in Combating Weapons of Mass Destruction (CWMD).

### Project funding

NSRI receives funding on projects from USSTRATCOM and other DoD and governmental agencies through task orders on a pre-competed Indefinite-Delivery Indefinite Quantity (IDIQ) contract. This contract allows funds to be received and quickly tasked for execution. Because the IDIQ contract is pre-competed in a set of research focus areas, it allows for government agency sponsors to award projects in those mission areas without going through a competitive bidding process. NSRI can also receive funding for research and development work through other contractual mechanisms as appropriate.

### A brief retrospective of NSRI highlights, 2012–2018

83

CONTRACTS AWARDED

24

SPONSOR  
ENGAGEMENTS

61

MILLION IN TOTAL  
AWARD VALUE FOR  
RESEARCH CONTRACTS

241

TASK ORDER  
PARTICIPANTS ACROSS  
UNIVERSITY SYSTEM



*"It is clear that the outstanding work our faculty and staff have done through the National Strategic Research Institute to protect our warfighters is just the beginning of what we're capable of...this contract renewal is a strong signal from the Department of Defense that the University of Nebraska's efforts are relevant, timely and worthy of continued investment. I couldn't be more proud of the team at NSRI and all the faculty who have been engaged in this venture for their success and commitment to keeping our country safe."*

**HANK BOUNDS**  
President, University of Nebraska





*Large-scale demonstrations:  
In July, 2018, NSRI and Nebraska  
Medicine helped to train 3,200 NDMS  
medical reserve corps members  
learning to put on PPE if responding  
to a chemical, biological, radiological  
or nuclear disaster.*

### **New National Capital Region (NCR) facility: Annapolis Junction, MD**

In 2017, NSRI opened a new state-of-the-art facility in Annapolis Junction, Maryland as a bridge between Nebraska and those in the nation's capital who are tasked with eliminating national security threats. The high-tech, secure facility includes offices, collaborative working spaces and interactive meeting areas that connect the facility's members with NU faculty and staff in Nebraska. A robust, high-bay training area at the facility provides ample room for demonstrations and is also frequently used by NSRI's All Hazards Response Training Team.

### **New Research Laboratory: Fredericksburg, VA**

On July 1, NSRI opened a new research laboratory in Fredericksburg, VA. Due to its proximity to the Naval Surface Warfare Center Dahlgren Division (NSWCDD), the facility provides NSRI with access to unique installation assets that are of interest to sponsors. It also allows enhanced collaboration between NSRI and area sponsors on project-specific functions, access to special logistics, and increased sponsor interaction.

### **New Research Laboratory: Albuquerque, NM**

On June 1, NSRI opened a new research laboratory in Albuquerque, New Mexico that serves as a unique lab focused on aerosol science, environmental microbiology, and biocontainment research. The new lab includes the Dynamic Test Facility, which is a flexible aerosol chamber and open jet wind tunnel designed to test aerosol collectors for unmanned systems in static and low wind speed environments, evaluate source terms from medical and other devices, and provide a contained space to study biological aerosols. The facility's proximity to Sandia National Laboratory and Los Alamos National Laboratories helps facilitate collaboration between NSRI and the National Nuclear Security Administration (NNSA) labs.



### **NCR CORE FUNCTIONS**

Facilitating large-scale meetings with sponsors

Providing a space for sponsor demonstrations

Engaging NSRI and NU researchers

Training opportunities for CWMD and CBRN-E

### **CAPABILITIES**

Interactive meeting space with seating for 110 people

Collaborative software suite and 68 interactive terminals that enhance collaboration and enable the capture of attributable and non-attributable data sets

30' x 6' configurable display wall for presentation and AV needs

10,000 square feet of training and flexible demonstration space with 30' ceilings, full drive-in capability, video capture, observation platform, and laboratory space



# Adapting to the non-state nuclear threat.

For decades after the initial development of nuclear capabilities, nuclear weapons were almost solely a threat of adversarial state actors. As the geopolitical landscape shifted in the late 20th century, however, the threat of smaller, more nimble terrorist organizations acquiring nuclear material increased significantly. This required America to develop new technologies and methodologies to adapt to this new environment.

The researchers of the University of Nebraska and the National Strategic Research Institute (NU/NSRI) are pioneering the development of novel technologies to detect nuclear materials and radiation signatures to increase speed, accuracy, and sensitivity over current methods. They also concentrate on developing capabilities that are safer for operators and allow for deployment in the field. Their long-term research objectives allow us to focus on:

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Detection of shielded materials

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Next-generation radiation detectors

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Detection of nuclear materials

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Pre- and post-detonation nuclear material characterization

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In our world-class facilities, our researchers are truly at the forefront of nuclear detection and forensics research that has nuclear security implications, applications for our nation's nuclear arsenal, and impacts both military and civilian nuclear operations.

## Stand-off detection of special nuclear materials

NU/NSRI recently set a record in the detection of Special Nuclear Materials (SNM) by developing a photon source that could detect SNM shielded by up to 40 cm of steel. We're continuing to develop the technology intensity and robustness to allow for a mobilized configuration for this photon source. Simultaneously, we're analyzing its capability in the detection and characterization of the chemical explosives often associated with nuclear threats.

## Commercial off-the-shelf (COTS) autonomous tracking and indicating prototype

Early detection and characterization of nuclear threats gives warfighters an undeniable advantage. NU/NSRI is developing, engineering and field-testing unique technology that uses Unmanned Aerial Vehicles (UAV) to deliver and deploy sensor emplacement systems.

## Detecting buried and hidden explosives using laser-driven high-energy electron beams

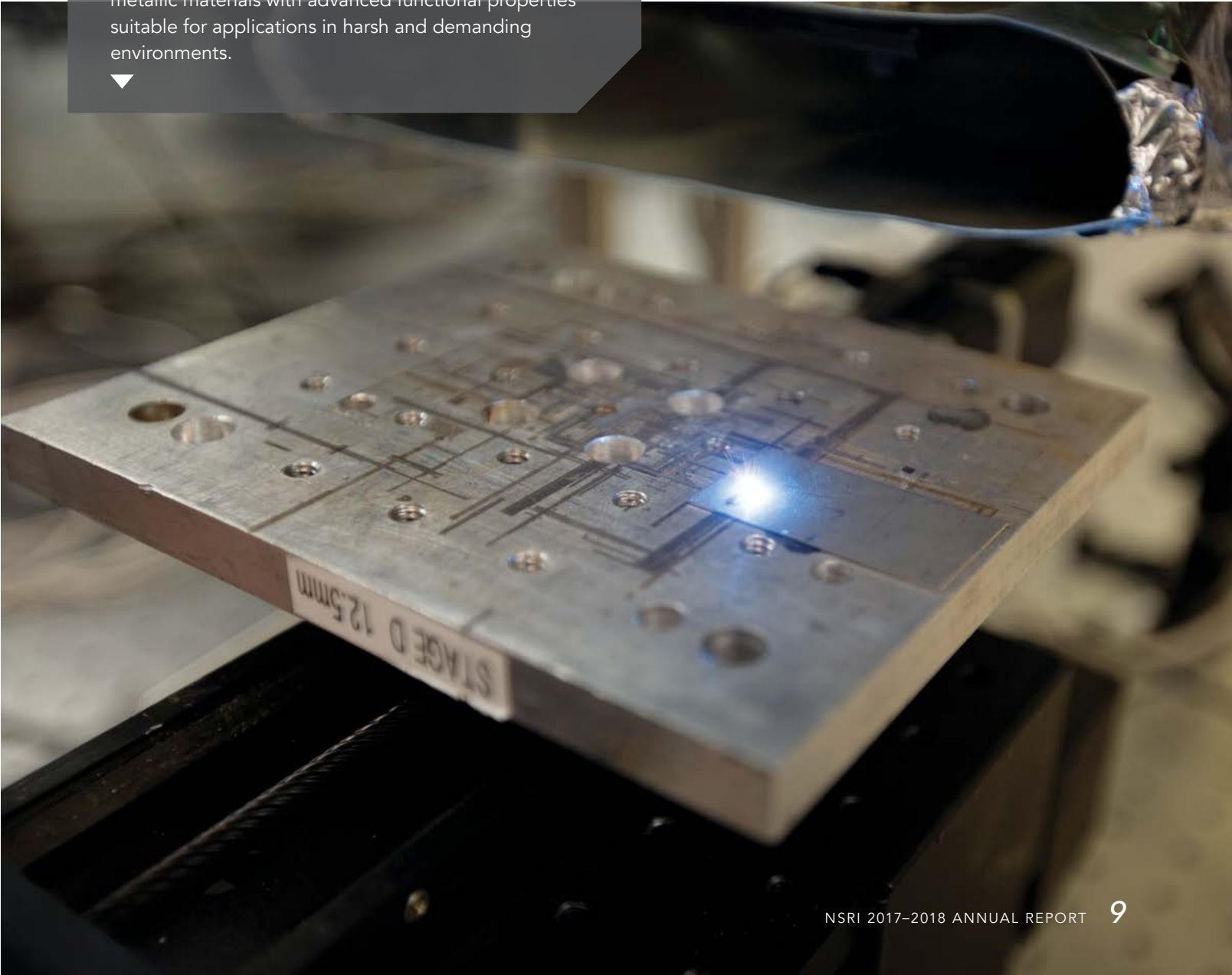
The DoD needs the ability to detect and identify chemical explosives when the line-of-sight between the detection system and the explosive is blurred, blocked, or otherwise obstructed. These weapons could be as crude as a weaponized Homemade Explosive (HME), as mobile as a Vehicle-Borne Improvised Explosive Device (VBIED), or could even be a component of an Improvised Nuclear Device (IND). NU/NSRI is developing an operational prototype based on a compact high-gradient laser-driven electron accelerator that can detect chemical explosives from a vehicle-based platform that could rapidly and accurately scan roadways and buildings for the presence of hidden, concealed, or camouflaged explosive threats.

### Revolutionizing metallic surfaces

NU/NSRI is actively pursuing the functionalization of a wide range of metallic surfaces that will exhibit permanency under extreme conditions and improve performance in targeted applications including heat transfer, drag reduction, remediation of WMD, and novel power sources. Femtosecond processing modifications at the micro, nano, and atomic scales of metallic surfaces are used to achieve performance improvements in critical applications. This research enables a long-term strategic goal of the DoD to develop revolutionary metallic materials with advanced functional properties suitable for applications in harsh and demanding environments.



▲  
*Dr. Dennis Alexander,  
Kingery Engineering Professor,  
University of Nebraska-Lincoln.  
Prof. Alexander and his group lead  
NU/NSRI's research into functionalized  
metallic surfaces for the DoD.*



# Developing life-saving programs to counter WMD attacks.

The effects of Weapons of Mass Destruction (WMD) on the human physiology and psychology are almost limitless in scope. Depending on the type of WMD, they will attack different parts of the human biological system. To counter the wide-ranging possibilities and effects of WMD on warfighters in the field, the researchers of the University of Nebraska and the National Strategic Research Institute (NU/NSRI) have a comprehensive R&D program. Our expertise, facilities, and resources are directed at the rapid development of Medical Countermeasures (MCM) — from the initial phases of exploration, design, and development to the more advanced phases of piloting, manufacturing and clinical trial execution. NSRI's researchers have demonstrated a record of performance in:

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Design & development of select agent vaccines

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Novel preventative & prophylactic treatments for neurotoxins

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Innovative approaches to vaccine and drug delivery

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Research, development, test, and evaluation of equipment providing therapeutic countermeasures for military and civilian use

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## Drug discovery and development pipeline

Regulatory constraints, a decrease in research entities, and other factors have led to an exponential decline in the availability of new therapeutic products over the last 50 years. NSRI supports the University of Nebraska Lincoln (UNL) and the University of Nebraska Medical Center (UNMC) in their efforts to increase the development and deployment of these medical countermeasures by establishing a drug discovery and development pipeline within a single entity. Our specific goal is to accelerate the progression

of candidate drug compounds and biologics through post-discovery testing and regulatory validation. Our pipeline focuses on the development of therapeutics to act as a defense against WMD, including acute radiation syndrome and highly infectious diseases.

## Center for Staphylococcal Research

The Center for Staphylococcal Research on the UNMC campus is the only research center in the nation focused on staphylococcal diseases. At the Center, researchers perform high-capacity genomic sequencing applications to survey highly complex populations of microorganisms or to look for variants within uniform populations. This research has helped the Center create the Nebraska Library, a collection of more than 1,900 mutants in which each non-essential gene of the invasive *Staphylococcus aureus* strain USA300 (MRSA) has been “knocked out.” This is all made possible by the Center's advanced capabilities, which include:

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Multi-user laser micro-dissection system to isolate and enrich biological material and cell populations in the  $\mu\text{m}$  size range

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In vivo imaging systems for real-time monitoring of bacterial infections and mammalian gene expression

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Bioflux system for simultaneous growth and microscopic analysis of multiple biofilms

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Capability for three-dimensional visualization of microscopic structure

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Anaerobic chamber

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PCR system for rapid, sensitive, and accurate measurements of gene expression

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NU/NSRI researchers develop innovative Medical Countermeasures (MCM) to combat the impact of WMD on warfighters in the field.





# Discovering and preparing for chemical & biological threats before their deployment.

As technologies advance, so do the capabilities of America's adversaries when it comes to the development, manufacture, and deployment of chemical and biological agents. The researchers of the University of Nebraska and the National Strategic Research Institute (NU/NSRI) are internationally recognized for their extensive expertise in the detection and identification of these agents, as well as for the development of clinical methodologies that detect exposure to them. Our research focuses on the accurate detection of known and unknown threats and the development of detection tools that are field-deployable, provide rapid results, detect bioactive levels, and require minimal training to use. In short, the nation depends on our detection and identification abilities when it comes to dangerous pathogens. NU/NSRI is unique in its:

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Expertise in genomics, transcriptomics, proteomics, metabolomics, and bioinformatics

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Development of autonomous and adaptive sensing, including the development of theoretical platforms to optimizing matured assays

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Partnership with government agencies to advance molecular assays with existing Department of Defense (DoD) technologies

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Repositories of select agents and capable facilities to both characterize these agents and evaluate therapies

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Synergistic relationship with the nationally recognized Nebraska Public Health Lab known for chemical and biological agent detection, assay development, and training

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## Biological field support

To ensure the most advanced clinical diagnostic capabilities and trained technicians are in place to respond to global biological threats, global training is critical. NSRI focuses on the development and

execution of training programs that include testing, protocol standardization, bioinformatics training, Next Generation Sequencing (NGS) capabilities at overseas military laboratories, and development of an Expeditionary Deployable Capability for Event Response.

## Biological defense and biosurveillance

NSRI provides technical and programmatic Biological Defense expertise to many DoD sponsors and operational components. Key accomplishments in 2018 include:

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Collaboration with University of Nebraska Medical Center (UNMC) to develop an extensive test and evaluation of a new analytical system for DoD laboratory assets

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Collaboration with University of Nebraska – Lincoln (UNL) to develop a novel, miniature sample prep device that can be carried by field operators for environmental and clearance sampling that improves repeatability and simplifies field operations

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We continue to work to:

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Develop and implement new sensing and interdiction technologies for combating biological and chemical weapons

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Bridge chemical and biological defense initiatives with U.S. and international medical and public health communities

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Facilitate the integration of biosurveillance, laboratory data, information, and analysis with Force Protection and Chemical, Biological, Radiological, Nuclear and Explosive (CBRN-E) information systems

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Coordinate, plan, and execute laboratory training, support, and advisory activities for events as designated by U.S. Government Sponsors

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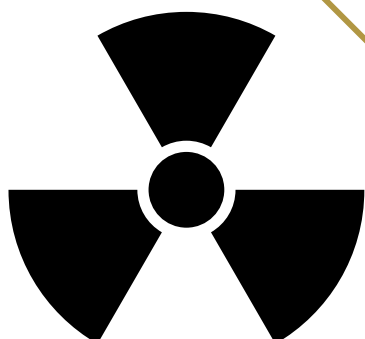
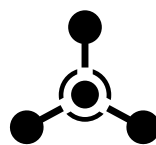
### Global Biosurveillance Portal & RedSky integration and information sharing

The NSRI facilitated the first information-sharing agreement of its kind between the Centers for Disease Control and Prevention (CDC) and the Department of Defense (DoD). By integrating platforms from those two agencies — the CDC's RedSky and the DoD's Global Biosurveillance Portal (GBSP) — relevant military and civilian alerts are enabled. It also provides warfighters with enhanced situational awareness of force health protection/all-hazard incidents. As a trusted agent of the government, NSRI continues to provide strategic guidance in support of further development and integration of the GBSP and RedSky.

### National Center for Health Security and Biopreparedness

Housed within UNMC's new iEXCEL facility, the National Center for Health Security and Biopreparedness (NCHSB) will be home to a state-of-the-art training and simulation center that fulfills a critical training need for federal health care workers in treating highly infectious diseases. The grant that funded the Center was awarded in part to the 2014 Ebola outbreak in West Africa and NSRI's involvement in training the medical professionals involved.

The center will feature collaboration spaces, three-dimensional/virtual immersive technology, augmented reality, advanced clinical simulation, pre- and post-briefing rooms, and a dedicated biocontainment patient care training space. It will also offer a comprehensive infectious disease training program developed by key subject matter experts, scientists and educators.



# Minimizing the consequences to maximize survival.

The National Strategic Research Institute (NSRI) views consequence management in terms of deterrence and response. When it comes to research on methodologies for deterrence, we work to anticipate, identify, and prevent the physical and virtual threats to the United States. Should a threat develop into a hostile action or disaster that requires an effective response during and after the crisis, our focus is on mitigating the negative consequences of the event through decision-making driven by data.

**Within consequence management, we focus on four broad areas:**

Chemical, Biological, Radiological, Nuclear and Explosive (CBRN-E) weapons response research and training

Critical cyber infrastructure protection

Decision-making and collaboration tools

Next-generation biocontainment capabilities and medical treatment in a contaminated environment

## Chemical, Biological, Radiological and Nuclear (CBRN) Preparedness Program (CP2)

NSRI played a critical role while serving as lead for the planning and execution of the CBRN Preparedness Program (CP2). A Security Cooperation Effort, CP2's mission is to build capability and capacity with International Partners for responding to CBRN/All-Hazard Threats in support of U.S. Combatant Command's Theater Campaign Plans. CP2 activities include Whole-of-Government Capability Assessments; development of Country Engagement Plans; equipping, planning and execution of training and exercises; and lifecycle sustainment. NSRI provided both technical and strategic subject matter expertise leading CP2 efforts while working with the Department of State, U.S. Combatant Commands, the Defense Threat Reduction Agency, and Partner Nations.

To date, this effort has successfully increased capabilities to detect and respond to CBRN/All-Hazard threats in seven foreign countries. The NSRI Team is effectively enhancing the Combatant Command and their Partner Nation's ability to prepare for and respond to CBRN/All-Hazard threats while strategically building interoperability between military and civilian agencies.

## Validation and verification of highly infectious patient transport systems

In the last several years, the infectious diseases team at University of Nebraska Medical Center (UNMC) has gained unique and invaluable experience in the transport and treatment of patients suffering from highly infectious diseases. They've applied their experience in caring for Ebola patients in the Nebraska Biocontainment Unit to develop a better understanding of en route care for patients being transported in isolation from remote locations. Through a combination of experiments and training exercises in 2018, UNMC, NSRI, and the University of Indiana worked closely with U.S. Air Force personnel to implement and evaluate technology, patient handling, and staff training/protocols for the Transportation Isolation System.







### Support to exercises CYBER GUARD and CYBER FLAG

In 2017, NSRI supported the Intelligence analysts at the two largest national cyber exercises — CYBER GUARD and CYBER FLAG. CYBER GUARD focuses on whole-of-nation defense in a simulated disaster, while CYBER FLAG provides training to develop the Cyber Mission Force's capabilities and readiness to execute. Leveraging a commercially available solution for knowledge management, collaboration, and analytics of cyber threat intelligence, NSRI successfully integrated 2000+ troops across four geographic locations and provided global situational awareness. The threat intelligence sharing reduced response action timelines by 12 minutes on average. That's a crucial 28% improvement in cyberspace timelines.

### ▲ Oxygenated microbubbles to treat patients with traumatic lung injury

Traumatic lung injury often leads to death, since the body relies on the lungs to provide oxygen. NSRI, through partnerships with the University of Nebraska Medical Center, the University of Nebraska - Lincoln, and the University of Colorado Boulder, is developing and validating a proof-of-concept, life-saving solution to this problem using oxygenated microbubbles. These microbubbles are engineered to bypass the damaged lung tissue and release oxygen into the abdomen. This is especially important to injured warfighters in low-resource environments and to people in mass casualty events where medical needs overwhelm available resources. To date, NSRI's research permits treatment of multiple casualties with minimal equipment and without the need for mechanical ventilation.

*Keely Buesing, MD, Asst. Professor, UNMC Department of Surgery (left) and Tobi Ogun, MD, (right) are two researchers exploring how microbubbles can be used to mitigate life-threatening risks to the lungs due to combat-related trauma.*





# Developing protocols for final frontiers.

When the Department of Defense (DoD) or its sponsors need mission-related research, the National Strategic Research Institute (NSRI) is there. Past mission-related research has included:

## Space, cyber, and telecom law, including analysis of legal issues and the development of protocols

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### Policies and strategies affecting:

Space traffic management

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Security and risk management of space and cyber assets

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Space, cyber, and telecom threats

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Convergence of cyberspace and CWMD pathways affecting mission readiness and national critical infrastructure resilience

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Space, cyber, and telecom deterrence theory and applications

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## Cyber Directorate

In the past several years, the term “cyber” has been used in relation to the geopolitical and military landscape. While the phrase itself has been in use since the 1980s as a shorthand for “cybernetics,” the DoD narrows its meaning even more. To the DoD and its partner agencies, “cyber” specifically refers to computer software or hardware that is weaponized to exploit, deny, degrade, disrupt, or destroy assets that are critical to national security. This includes any systems, facilities, people and any of their possible combinations.

The NSRI’s Cyber Directorate’s focus is just as narrow. It concentrates on the use of cyber as a tool used by the nation’s adversaries to inform WMD attacks, increase their effectiveness, or to create mass effects independently.

Supported by our consultants and academic teams, our staff has decades of experience in cyber defense, cyber operations, intelligence analysis, agile development, and cyber exercises. We leverage staff at both the University of Nebraska – Lincoln and the University of Nebraska – Omaha for research expertise in machine learning, operational network security, human machine interactions, information assurance, cyber law, and more.

## NSRI’s Cyber Directorate specialties

### Use cyber training and exercises to:

Refine operational requirements

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Advance analytic solutions

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Create agile capabilities

---

Rapidly transition to operations

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### Sharpen the focus on:

Intelligence sharing

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Cyber situational awareness

---

Collaboration to enable decision-making at speed and scale

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Building repeatable frameworks to evaluate cyber threats, vulnerabilities, and defenses for Information Technology and Operations Technology (IT/OT) and Industrial Control Systems (ICS)

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## Nuclear Mission Planning System

In light of the cyber capabilities of our adversaries, NSRI’s Cyber Directorate is reviewing and refining the cyber security architecture for the Nuclear Mission Planning System. This assists the DoD in its requirement of ensuring it has the ability to perform crisis action planning that can withstand attempts from skilled adversaries working to offset the Nation’s deterrence mission through cyber-attacks.

## Port security

In many environments, the computer networks that create operational efficiencies also create security vulnerabilities. This is especially true in heavily trafficked maritime ports, where seagoing vessels and shore crews coordinate through these networks. In 2018, NSRI convened representatives from ports around the country at our new National Capital Region Facility in Annapolis Junction, Maryland. This important discussion identified the best ways to engage with private industry partners in order to defend the cyber infrastructure of American ports — a critical mission for both national and economic security.

## Advanced Operational Law Conference

NSRI and the University of Nebraska College of Law host an annual Advanced Operational Law Conference to explore legal perspectives related to questions regarding national security in the 21st century. The conference features leading international legal policy experts from both academia and government who participate in classified and unclassified discussions on unique legal and national policy limitations imposed on military operations.

At the inaugural conference in 2017, topics focused on international law applicable to military uses of outer space, rogue states, and nuclear weapons, as well as limitations on cyber operations and issues of sovereignty in cyberspace. Attendees included legal and policy experts, practitioners, and academics.

## Improved decision-making across the DoD

The information and data gained from the battlefield is so immense that it inhibits the ability to discover, analyze, and provide actionable information to decision maker. NSRI is working to use machine learning to increase the speed and scale of analysis by discovering the platforms, data, and algorithms able to analyze thousands of reports and millions of events. Our goal is to provide the best situational awareness in the shortest timeframe possible. We are applying expert tradecraft from experienced analysts to the multitude of data available and interpreting results for all levels of analysts and decision makers.

*"The nature of our national security and those of our allies is both politically and legally complex and these conferences reinforce our partnerships and hone our thinking. I am very grateful that I had a chance to participate and I look forward to continuing the relationship with USSTRATCOM and the University of Nebraska."*

**Susan Arnold**

**U.S. Army Brigadier General**

**U.S. Army Assistant Judge Advocate General  
for Military Law and Operations,**

**Keynote Speaker at 2017 Advanced  
Operational Law Conference**





NSRI EDUCATION & TRAINING

## Practicing adversity to diminish its potential.

### All Hazards Response Training

The National Strategic Research Institute (NSRI) employs a robust, mobile All Hazards Response Training (AHRT) capability to help prepare government agencies, law enforcement, public health officials, and first responders to mount an effective response to a WMD event. Our AHRT team provides Chemical, Biological, Radiological, Nuclear and Explosive (CBRN-E) training to improve their counter-WMD preparedness. It's the only program in the nation that combines premier academic research to Combat Weapons of Mass Destruction (CWMD) with seasoned CBRN-E professionals. AHRT designs seminars and exercises around specific mission requirements and objectives, making it one of the most requested CWMD preparedness training programs in the nation. In the past 12 months, AHRT Cadre have completed ten full-scale exercises and eight special-request, customized courses, while training more than 4,600 personnel.



*NSRI subject matter experts provide Chemical, Biological, Radiological, Nuclear and Explosive (CBRN-E) training to first responders in a National Level Exercise (NLE).*

### Inside an AHRT Training Event

AHRT Cadre coordinated a two-day training exercise for a National Guard Civil Support Team (CST) that incorporated the country's pervasive fentanyl problem into a CBRN-E threat. The exercise simulated a terrorist plot to poison key political officials with Bio-warfare agent (simulant) by an anti-government terrorist cell. To fund their efforts, the terrorist group was manufacturing and selling fentanyl in the same facility.

As SWAT units arrived on the scene, an exchange of gunfire pierced a fentanyl container and contaminated everyone in the vicinity. This required CST to advise the HAZMAT team on decontamination after SWAT eliminated the threat. The teams then entered the facility, found the lab, and collected test samples before requesting the FBI's WMD Coordinator to the scene.

By developing and guiding the field-training exercise, AHRT afforded local first responders and National Guard teams with hands-on experience in a WMD multi threat response using the most up-to-date CBRN-E response procedures. They also provided participants with the training to work through complex challenges involving inter-agency relationships, command structure, and communication. Should a real-world situation arise, they're much better prepared to handle the threat.





◀ *NSRI's AHRT provides exercise and training platforms with realistic scenarios for Civil Support Teams and other government agencies (OGA's) that are most likely to be involved in WMD response and counter-terrorism operations at or overseas.*

### Academic Wargaming Center

Through roleplaying, NSRI's wargaming reveals variables in complex and competitive situations that wouldn't necessarily arise in simple discussions or brainstorming. Participants gain insight into their decision-making that can easily apply to any competitive scenario, from global politics to local business to risk management teams. The center is a unique venue that allows military, academic, government, and commercial entities to work together towards solving the country's most perplexing issues.



### ▲ Strategic Leadership Fellows Program

Designed to develop high-potential civilian leaders to broaden mission awareness and support of USSTRATCOM's organizational transformation, this program includes classroom-based and hands-on learning opportunities. The overall objective: advance a workforce capable of synthesizing diverse national security issues so that they can more effectively plan, coordinate, and advocate for global operations and capabilities that counter CBRN weapons and advance national/international cyberspace law.

### DTRA Postdoc Fellows

NSRI connects professionals from academia, industry, government, and the military to develop and deliver the most advanced solutions possible in combating WMD. In June 2018, the Defense Threat Reduction Agency (DTRA) tapped NSRI to identify, attract and recruit candidates from each of these sectors to serve as Postdoctoral Scholars (PDS) and advance their knowledge of national security challenges and the business of government.

### Biological Training & Biodefense

NSRI and the University of Nebraska ensure the nation can effectively combat infectious diseases in the future with two programs. Biological Applications, Research, and Training (BART) is a joint operations, training, and research effort between NSRI and the Naval Medical Research Center's (NMRC) Biological Defense Research Directorate (BDRD) that develops a critical pipeline of human resource assets in STEM areas for the armed forces. The Biodefense Research Education Pipeline (BREP) recruits qualified students to join the fight against infectious diseases, offering them hands-on experience in laboratories conducting DoD-related research.

*U.S. Navy Vice Adm. Charles Richard (center), deputy commander of U.S. Strategic Command, attends the 2018 USSTRATCOM Strategic Leadership Fellows Program kickoff along with program participants. Pictured (L-to-R): Naviere Walkewicz, Rod Reidy, Ty Miles, Dan Nyberg, Vice Admiral Charles Richard, Ed Lyle, Les Harris, Bren Workman, Shane Ehlin, Jim Beall, Becky Vance*





#### STUDENT AND FACULTY ENGAGEMENT

## Developing partnerships for the greater good.

▲ Adam Plowcha, PhD student in the Department of Computer Science and Engineering at the University of Nebraska, Nebraska Intelligent Mobile Unmanned Systems (NIMBUS) Lab.

As an academic research institute, the National Strategic Research Institute's (NSRI) accomplishments are supported by the efforts of the University of Nebraska's (NU) faculty, students, and researchers. Every year, they make breakthroughs in areas once untouched or undiscovered. In turn, the warfighters take the opportunity to engage, educate and train those associated with the university in subject matters that would be unavailable if not for their relationship with the Department of Defense (DoD) and its partners.

*"The NSRI has a pivotal role in the successful collaboration between our three campuses and the Air Force Surgeon General (AFSG). In addition, the Center for Advanced Surgical Technology (CAST) here at UNMC has provided key personnel and facilitated acquisition of resources. It's been a pleasure to be part of a team dedicated to advancing translational research to expand treatment options for our critically ill patients."*

*Dr. Buesing*

#### FACULTY SPOTLIGHT



#### **Dr. Carrick Detweiler**

The Susan J. Rosowski Associate Professor of Computer Science and Engineering at the University of Nebraska, Professor Detweiler is working on a multi-year project to develop advanced Unmanned Aerial Systems (UAS)

that directly interact with the environment and can deploy and install sensors in remote locations.

#### **Dr. Keely Buesing**

Keely Buesing, MD, FACS and Assistant Professor in the Department of Surgery at UNMC leads a multi-institutional investigation of a novel method of providing supplemental oxygen for patients with severe lung injury. NSRI has funded these collaborative efforts between researchers at the University of Nebraska Lincoln and the University of Colorado Boulder since 2016.



## INTERN SPOTLIGHT

### Dylan Christiansen

A UNO student studying computer science and cybersecurity, Dylan received the Walter Scott Jr. Scholarship. He also works as a software engineer intern at NSRI, where his research into Augmented Reality (AR) and Virtual Reality (VR) technologies has included development of proof-of-concept capability demonstrations in a simulated air traffic control environment and a multi-player wargaming project.



### 2018 Strategic Academic Wargame

Held in April of 2018 on the UNO campus and hosted by the NSRI's Academic Wargaming Center (AWC), this unique pilot event tested wargaming as a research tool, while addressing the timely topic of strategic messaging using social media platforms. Students and faculty from UNO and UNL were exposed to an engaging learning tool rarely used in academic settings. The event successfully proved that wargaming provided a synergistic interaction between military, academic, government, and commercial entities and could address the country's most complex challenges.

## STUDENT SPOTLIGHT



### Adam Plowcha

Adam Plowcha is a retired U.S. Navy helicopter pilot who is now a PhD student in the Department of Computer Science and Engineering at the University of Nebraska. As part of the Nebraska Intelligent Mobile Unmanned Systems

(NIMBUS) Lab, his research examines autonomous action and decision-making for Unmanned Aircraft Systems (UAS). Plowcha has been working on the NSRI/USSTRATCOM effort to create a UAS capable of autonomously installing a sensor in a remote location. He's focused specifically on the development of the UAS digging capabilities and the system's ability to predict when, where and why it wouldn't succeed in emplacing a sensor.

### Santos Ramos

A graduate research assistant at the Mid-America Transportation Center (MATC), Santos is studying Transportation Engineering in the Civil Engineering Master's program at the University of Nebraska-Lincoln. In less than a year, Mr. Ramos has developed in-depth knowledge of traffic simulation software — such as Synchro 9 and Vissim 9 — to develop traffic simulation templates that replicate Early Control Facilities in order to study their traffic behavior and characteristics. Through his experience, he plans on pursuing the field after graduate school.



### Larry D. Welch Deterrence Writing Award

Sponsored by United States Strategic Command (USSTRATCOM), these annual awards are presented to a Senior Researcher and Junior Researcher for the best papers on strategic deterrence. The competition is open to students across the nation whose papers are judged by a team of deterrence experts in categories that include how well their solutions apply to current deterrence issues, the quality of their arguments, and their historical accuracy. Winners receive the award at the USSTRATCOM's Annual Deterrence Symposium on behalf of the Commander. While the competition is national, the 2017 winners didn't need to travel far for their award: the winning team was composed of students from the University of Nebraska at Omaha.

*Gen John Hyten, Commander, USSTRATCOM, accompanied by NSRI Executive Director Lt Gen (ret) Bob Hinson, presented the award to (L-to-R), Ms. Shelby Haas, Ms. Bethany Vaillant, and Ms. Media Ajir.*

## **Influence of Copper Oxide on Femtosecond Laser Surface Processed Copper Pool Boiling Heat Transfer Surfaces**

UNL

Corey Kruse, Alfred Tsubaki, Craig Zuhlke, Dennis Alexander, Edwin Peng, Jeff Shield, Sidy Ndao, and George Gogos  
Journal of Heat Transfer

## **Hidden in Plain Sight:**

### **The Liberian Lassa Fever Endemic**

UNMC/USAMRIID

M. Wiley, L. Fakoli, A. Letizia, J. Ladner, K. Prieto, N. Espy, J. Chitty, S. Sozhamannan, F. Bolay, C. Albariño, M. Fallah, and G. Palacios  
Cell Reports

## **Laser Scanning Confocal Microscopy Technique for Imaging and Measuring Plastron Attachment to a Submerged Superhydrophobic Surface**

UNL

Chongji Huang, Craig A. Zuhlke, Ryan Bell, Alfred Tsubaki, Troy P. Anderson, and Dennis R. Alexander  
Physical Review Letters

## **Qualitative profiling of the humoral immune response elicited by rVSV-ΔG-EBOV-GP using a novel systems serology assay, Domain Programmable Arrays**

UNMC/USAMRIID

M. Sanchez-Lockhart, D. Reyes, J. Gonzalez, K. Garcia, E. Villa, B. Pfeffer, J. Trefry, J. Kugelman, M. Pitt, and G. Palacios  
Cell Reports

## **Creation of micro/nano surface structures on silver using collinear double femtosecond laser pulses with different pulse separation**

UNL

Nicholas Roth, Craig Zuhlke, Edwin Peng, Scott Hansen, Jeffrey E. Shield, and Dennis Alexander  
Multiscale and Multidisciplinary Modeling, Experiments and Design

## **Electrical and Structural Characterization of Neutron Irradiated Amorphous Boron Carbide/Silicon p-n Heterojunctions**

UNL

Michael Nastasi, George Peterson, Qing Su, Yongqiang Wang, N. J. Ianno, Nicole Benker, Elena Echeverría, Andrew J. Yost, J. A. Kelber, Bin Dong, and Peter A. Dowben  
Materials Science and Engineering

## **Genetic characterization of Enterovirus A71 circulating in Africa**

UNMC/USAMRIID

Maria Dolores Fernandez-Garcia, Romain Volle, Marie-Line Joffret, Serge Alain Sadeuh-Mba, Ionela Gouandjika-Vasilache, Ousmane Kebe, Michael. R Wiley, Manasi Majumdar, Etienne Simon-Loriere, Anavaj Sakuntabhai, Gustavo Palacios, Javier Martin, Francis Delpeyroux, Kader Ndiaye, and Maël Bessaud  
Emerging Infectious Disease

## **Genomic Characterization of human Monkeypox virus circulating in Nigeria, September 2017**

UNMC/USAMRIID

O. Faye, C. Pratt, M. Faye, G. Fall, J. Chitty, M. M. Diagne, M. R. Wiley, A. F. Yinka-Ogunleye, S. Aruna, E. N. Etebu, N. Aworabhi, D. Ogoina, W. Numbere, N. Mba, G. Palacios, A. A. Sall, and C. Ihekweazu  
Lancet

## **Fundamentals of aggregated nanoparticle spheres formed through femtosecond laser surface processing**

UNL

Alfred T. Tsubaki, Mark A. Koten, Michael J. Lucis, Craig Zuhlke, Natale Ianno, Jeffery E. Shield, and Dennis R. Alexander  
Applied Surface Science

## **Improved a-B10C2+xHy/Si p-n heterojunction performance after neutron irradiation**

UNL

George Glenn Peterson, Qing Su, Yongqiang Wang, Natale J. Ianno, Peter A. Dowben, and Michael Nastasi  
Journal of Vacuum Science & Technology

## **Growth Mechanisms of Multiscale, Mound-Like Surface Structures on Titanium by Femtosecond Laser Processing**

UNL

Edwin Peng, Ryan Bell, Craig A. Zuhlke, Meiyu Wang, Dennis R. Alexander, George Gogos, and Jeffrey E. Shield  
Journal of Applied Physics

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